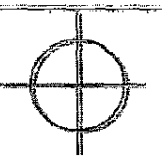
bio markers



WHAT ARE BIOMARKERS ?

One of the main problems of ecotoxicological research is the evaluation of exposure of natural communities to contaminants and the effect of these compounds on them. To tackle this problem, modern environmental toxicology has gradually combined biomonitoring studies, based on estimates of residue levels in bioindicator organisms, with a new approach based on evaluation of the responses of an organism, population or natural community to chemical stressors in the environment. These responses, defined as biomarkers, constitute an integrated signal of the level of contamination in a given area, and are therefore also an indicator of the level of toxicological risk to which a given natural population is exposed (Bayne et al. 1985, McCarthy & Shugart 1990, Depledge & Fossi 1994).

•A biomarker is defined as "a change induced by a contaminant in the biochemical or cellular components of a process, structure or function, that can be measured in a biological system" (NRC 1989). This change provides qualitative and semiquantitative information on the nature of chemical insult, and information on the relation between biological effects and levels of environmental contamination. A basic concept on which this new methodological approach is based is the intercorrelability of the effects of a contaminant at different levels of structural organization (Bayne et al. 1985). The primary toxicity of a contaminant is generally felt at a biochemical and molecular level (changes in enzyme activities, DNA, etc.) and only later at levels such as those of the organelle, cell, tissue, organism, and eventually population. The different homeostatic and other responses to chemical insult generated by organisms are therefore potential biomarkers for ecotoxicological

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research (McCarthy & Shugart 1990, Depledge & Fossi 1994).

• What has this approach contributed to the evaluation of environmental risk due to contaminants? Biomarker evaluation in bioindicator organisms sampled in one or more areas suspected of contamination, and compared with organisms from a control area, enables the potential danger to a community or communities to be assessed (Depledge 1989, McCarthy & Shugart 1990, Fossi 1991, Depledge & Fossi 1994). The advantages and limits of this approach with respect to conventional methods of biomonitoring are as follows:

biomarkers provide an integrated response to the overall exposure of the bioindicator species, including the sum of all the different intake routes and of exposure in time, within a given geographical area;

• biomarkers provide an integrated response to all the toxicological and pharmacological interactions of the mixture of compounds to which a sentinel organism is exposed.

• biomarkers provide an immediate response to exposure to a toxic substance.

• a current limit of biomarkers, which will be the subject of future research, concerns the relation between individual response and ecological effects: evaluation of the long-term ecological effect of a contaminant depends on whether or not the organism has been exposed to contamination levels exceeding normal homeostasis and compensation.

• certain multienzyme reactions (MFO system) undergo modifications in relation to the hormonal status, age and sex of an organism; this limit can be partly obviated if the reproductive cycle, physiology and variations between individuals of the sentinel species or bioindicator are known

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• Some of the main biomarkers used in ecotoxicological research in relation to heavy metals and organic contaminants are indicated in Table 1. These biomarkers provide three different types of information: warning of a potential problem, the presence of a specific class of contaminants and an indication of possible long term ecological effects on population or community.

TABLE I

BIOMARKERS AND THEIR MEANING

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CONTAMINANT	BIOMARKER	WARNING *
Heavy Metals		
Cu, Hg, Ag, Zn, Cd, Pb	DNA changes	S
	Metallothioneins	S D
	Porphiria	S D P
	Immune response	S
	MFO	S
Organic compounds		
1.PAHs	DNA changes	SDP
	MFO	SD
	Immune response	S
2. PCBs, DDT,HCB,TCDD		
	MFO	S
	Porphiria	S
	Immune response	S
	DNA changes	SD
3.ORGANOPHOSPHATES	Blood esterase activities	SD
CARBAMATES.	Brain esterase activities	SDP

S = signal of potential problem
D = definitive indicator of type or calass of pollutant
P = predictive indicator of a long-term adverse effect.

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